Warm pixels in EIS data

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I have come to the conclusion that a lot of the noise in the EIS CCD images are the result of what I call 'warm' pixels. These are different from hot pixels although I am not sure how these are identified.

I have gone about this in the following way:

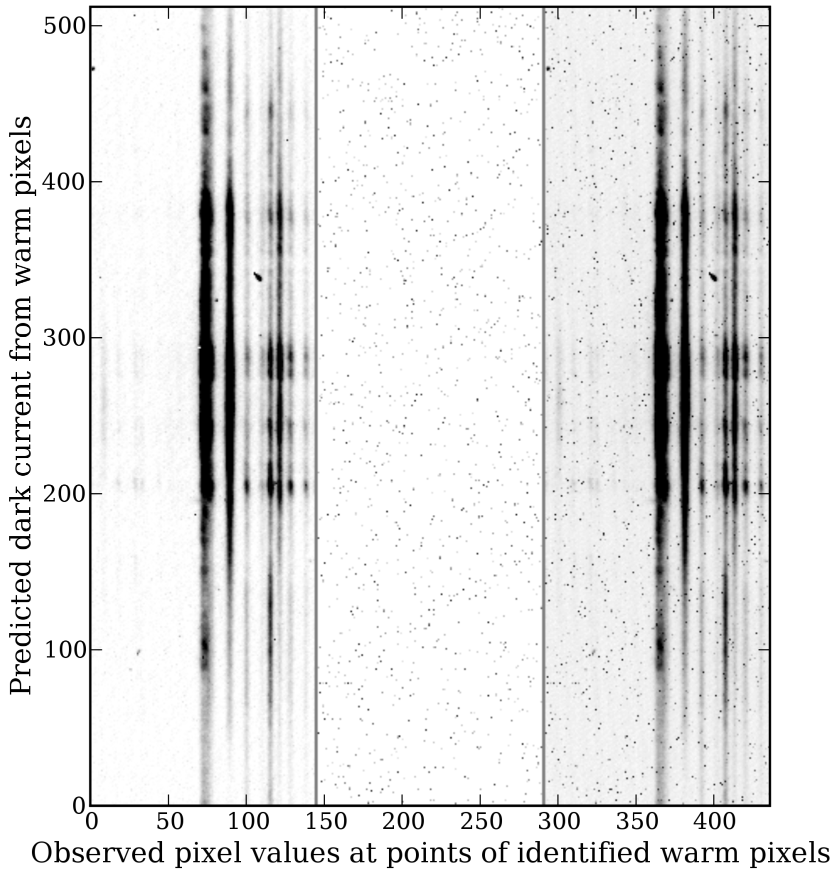
1. Remove the dark current. I have taken the images recorded with regcal016 to arrive at a dark current level. In fact, I have collected about all of these and use the one closest in time.

2. Get the dark current rates from 100s exposures obtained with regcal016. First, I subtract the dark current. I do this by calculating a cumulative histogram for both exposures and match them at the 10% level. Then I discard all pixels that are identified as hot pixels from the hot pixel files in SSW. After this, any pixel that has a value of 12 DN qualifies as a warm pixel and the dark current rate is calculated and saved in a file. Again, I think I have most of the regcal016 files obtained to date.

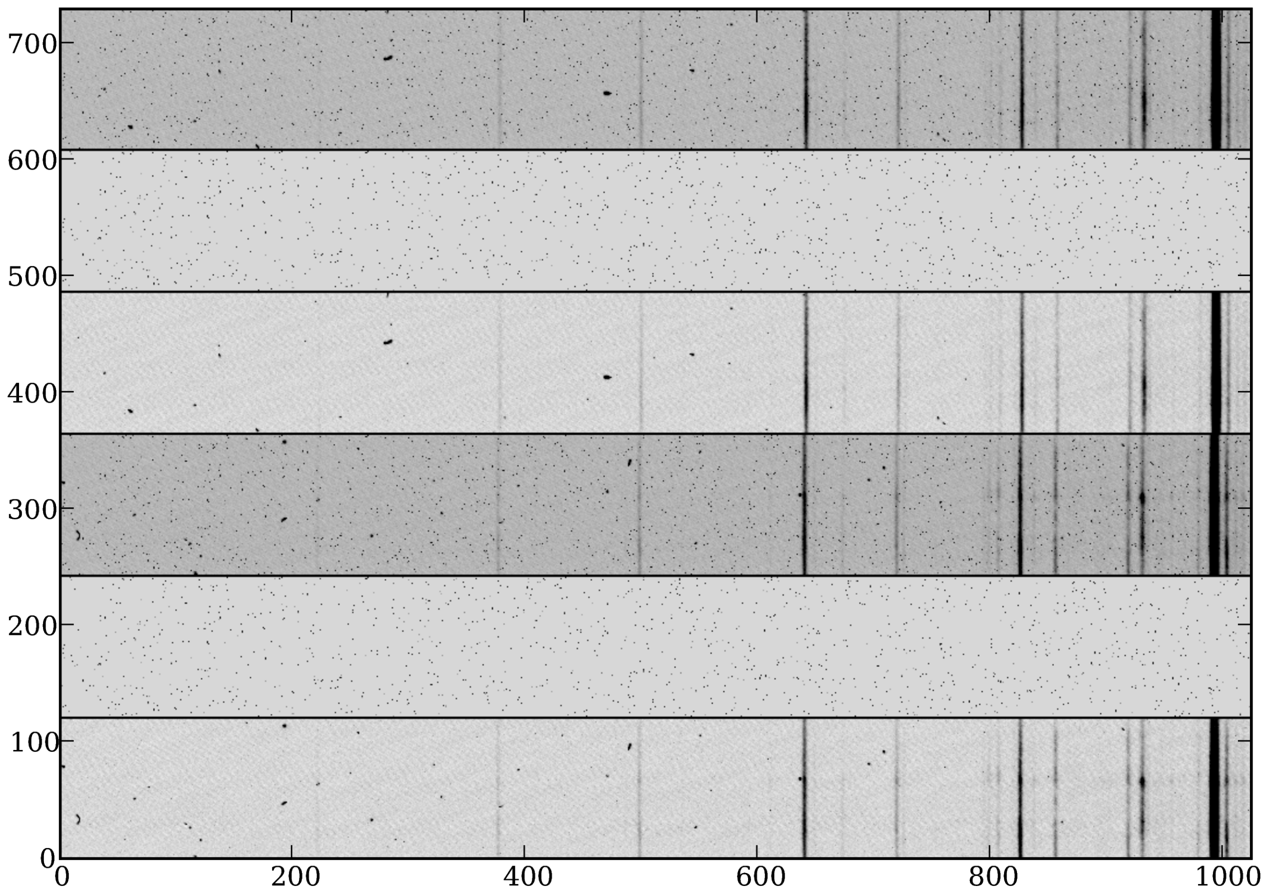
3. Then I apply these same basic steps to real data: subtract the dark current, replace the hot pixels with median values, replace the warm pixels were the dark current value is predicted to be greater than 10 with their median values. So far, everything has been fixed cosmetically but we do know the positions of the 'bad' pixels and we know them from prior information.

So, does this actually work?

The following figure shows a 512 pixel-high x 144 pixel-wide window that includes He II 256 and some other lines obtained with a 60s exposure time. ON the right, is the original data, in the center is the predicted current and on the left is the cleaned data where the dark current has been subtracted, the hot pixels and the warm pixels have been replaced with their median values. Looks pretty good to me.

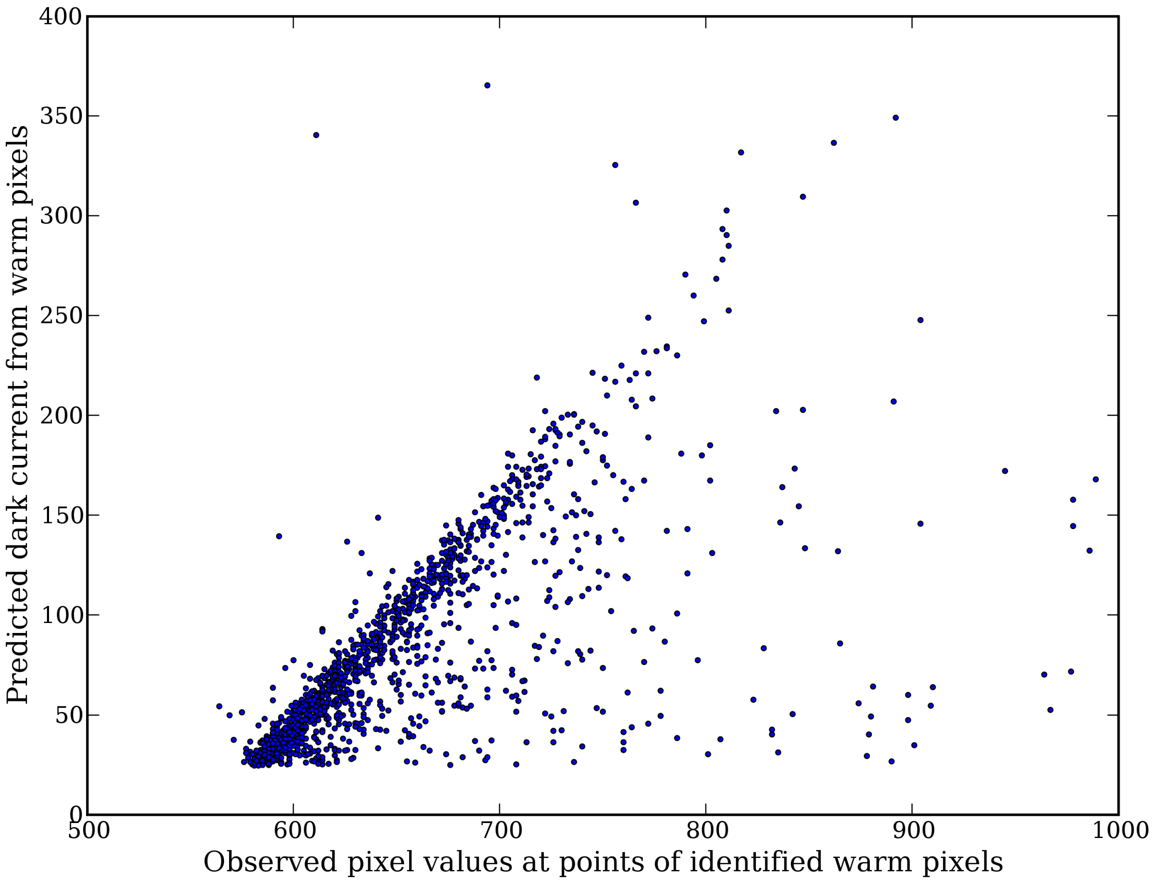


Next are two 128 high full CCD image taken with 60s exposure times. These are window 0, the shortest wavelength. Top most is the original data, next the predicted dark currents and next the cleaned version. The same is repeated for a different exposure in the same raster below. A comparison of the two indicates where the real cosmic rays can be found.



This procedure clearly gets rid of a lot of bad stuff but the question is, does it also get rid of good stuff. Below is a plot of predicted dark current from warm pixels versus what is actually observed. The bulk of the points seem to lie close to a line with a slope of 1, indicating that there is some validity to this. The fact that most of the pixels are to the right of the line indicates that the effect of the dark current due to the warm pixels is worse than predicted. The fact that few points lie to the left of the line indicates that we haven't really over-corrected too often.

So, I believe that we should try identifying all the known defects in the CCD images before we work with them. Based on the few comparisons I have done so far, most of which you see here, it may be that these steps are sufficient.



Predicted dark current from warm pixels
Observed pixel values at points of identified warm pixels
0
50
100
150
200
250
300
350
400
500
600
700
800
900
1000